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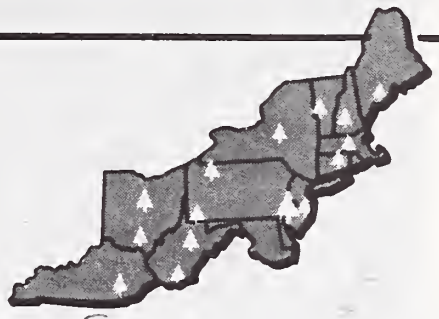

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WOOD CHIPS FOR DUST CONTROL ON SURFACE-MINE HAUL ROADS

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Abstract. On a coal haul spur road where water sprinkling was the primary method of dust control, the duration of control was increased tenfold by covering the road surface with a layer of wood chips. The chip blanket prevented existing dust-size particles from being kicked up and swept into plumes by passing traffic, insulated the road surface against evaporation and protected it from the pounding and abrasion of truck tires.

INTRODUCTION

Dust stirred up from the surface of haul roads serving coal surface mines in Appalachia has a number of disagreeable and hazardous impacts. This airborne dust is a readily visible detraction from what might otherwise be a model of mining and reclamation work. It is a hazard to health and safety. Inhalation of dust particles contributes to respiratory problems for persons who live and work near these roads. Dust plumes raised by passing vehicles often drastically reduce sight distances for drivers of approaching or following vehicles. At times, for periods of several seconds, visibility is so reduced that those drivers can hardly see beyond their own windshields. Both coal operators and regulatory agencies recognize that such conditions are undesirable and unsafe. Mine Safety and Health Administration (MSHA) regulations require that haul roads be treated to alleviate dusting conditions.

Coal haul roads may be separated into two basic groups; main routes and spur routes. Main routes generally serve several operations either simultaneously or consecutively; spur routes usually serve only one or two permits and their life is measured in weeks or months. The sub-base of both types consists of particulate materials derived from the native sandstone, siltstone, and shale strata traversed by the route. On main routes this may be topped with a base course of limestone gravel which also serves as the wearing surface. But the wearing surfaces of spur routes are particu-

late materials derived from whatever native strata the road penetrates. Often, substantial portions of spur routes consist of benches left by previous mine operations. In those cases mine spoil serves as the road surface material.

Dust and dust-related problems are endemic to roads in both groups. Controlling dust on coal haul roads requires continual attention, effort, and expense, and success varies widely from road to road and from hour to hour upon any given road.

The most common method of dealing with haul road dust problems is to wet the road surface from water trucks with sprinklers. Normally this method yields acceptable results. However, increases in vehicle traffic, temperature, and wind velocity, or decreases in humidity, can cause conditions to deteriorate quickly. When this happens, water trucks must make more frequent passes or apply more water with each pass. In either case, the number of miles of road that one truck can treat acceptably is reduced and more trucks are needed to properly treat the entire length of haul road. Adding to the problem is the fact that in many cases sources of water for sprinkling tend to dry up. Thus, both distance to supply and time required to take on a load of water increase, and the effective working time of a sprinkler truck is cut.

THE STUDY

In August 1978, we conducted a preliminary field investigation of the ability of wood chips to reduce airborne dust on a coal haul road. The results strongly suggest that the use of wood chips will allow a significant reduction in whatever day-to-day use of sprinkler trucks is required to control dust on surface-mine haul roads. The chip blanket acts to conserve moisture within the road surface by reducing evaporation rates. This reduces the volume of water required to be added by sprinkling. In dry periods when water supplies are low, this reduction alone might well make the difference between having and not having the ability to control dust.

But this is not the whole story. Even in periods when adequate water is available, the use of sprinkler trucks on a haul road system will be reduced, yielding greater flexibility in scheduling and an increased ability to sprinkle major haul roads where heavy, high-volume traffic may make it unwise to adulterate gravel surfaces with wood chips.

It was also noted that the chip blanket was somewhat disturbed by the partial vacuum created by fast moving coal trucks and by the pounding and abrasion of the truck tires. Where the blanket was not present, these forces were applied directly to the road surface. There, dust particles were easily swept into plumes and additional dust-size particles were developed from the road material. Where chips were present, they mitigated the formation of dust plumes and reduced the creation of new dust-size particles.

Methods and Materials

In this experiment, a segment of spur haul road in Breathitt County, Kentucky, was covered with wood chips. The road segment was approximately 100 meters long, averaged 8 meters wide, had a grade of from 0 to 3 percent, and incorporated a gentle"S" curve. The treated segment was located about 200 meters from the intersection of the spur route with the main haul road. It was bounded on each side by small berms thrown up during the grading and shaping of normal road maintenance (Fig. 1), and its surface was composed of particles derived from the siltstone, sandstone, and shale strata native to the site (Fig. 2).

The wood chips used were the result of processing whole trees—trunk, limbs, and leaves—recently cleared from a mine site. The trees were hardwoods—oaks, hickories, and gums—native to the area. They were chipped in the morning, hauled 50 miles (80.5 km) to the experimental site in a covered semi-trailer, and applied that same afternoon with a motor grader normally used in road maintenance (Fig. 3). Chips blanketed the treated road segment to a thickness of from 3 to 6 cm. Achievement of a more uniform thickness was prevented by variation in the size and shape of the chips and our desire to keep the chip layer free of contamination with scrapings from the road surface. In all, approximately 28.4 cubic meters of chips were used.

From 11:00 a.m. of the first day of observation until 12:00 noon of the second day

Figure 1.—Road segment before wood chip treatment: 11:00 a.m., first day.

Figure 2.—Material typical of road surface in and near treated segment: 11:00 a.m. on first day.

Figure 3.—Motor grader spreading wood chips into blanket covering road surface: 2:30 p.m. on first day.

a hygrothermograph continuously monitored ambient air temperature and humidity at the site. Measurements and photographs were made and samples of road surface materials and chips were taken for laboratory tests during two distinct periods: from 3:00 p.m. until 5:00 p.m. on the day the chips were applied, and from 8:00 a.m. until noon the following day.

Samples for laboratory testing, measurement, and analysis were taken at the beginning and end of each observation period. Field tests of the moisture content of the road surface material and of the chips were made at those same times, as well as at approximately 1-hour intervals during the observation periods.

Four samples of chips were randomly selected for measurement of chip length, width, and thickness. The length dimension ran with the grain of the wood. Width was the larger and thickness the smaller of the two remaining dimensions. Both width and thickness were measured at right angles to the run of the grain.

A count was made of vehicles traversing the experimental road segment during the two periods of observation. The vehicles were categorized as loaded coal trucks, empty coal trucks, or passenger/service vehicles. The speeds of coal trucks, both loaded and empty, were also measured.

Results

Moderate rain, (estimated at 0.7 cm), on the evening before the wood chips were applied and passage of the sprinkler truck 30 minutes before the chips were spread caused the moisture content of the road surface material to be relatively high at the time of chip application.

Ambient temperature and humidity at the site from 11:00 a.m. of the first day of observation until 12:00 noon of the second day are shown in Figure 4. Also shown are changes in the moisture content of the road surface material. Line A depicts temperature, line B depicts humidity, and lines C and D depict changes in road material moisture content for that portion of the road covered by chips and for adjacent sections not covered by chips respectively. Dotted portions of lines C and D depict estimated moisture content levels during the night hours when no measurements were made.

The slope of the moisture content curve (Fig. 4, line C) for the treated segment is much shallower and much less affected by ambient humidity than is the curve (Line D) that describes the moisture content of the untreated road surface. The overall moisture loss rate on untreated segments was 2.5 times that of the treated segment.

The particle size distribution of materials in the upper 40 mm of the road surface is plotted in Figure 5. Its liquid limit was 17 and its plastic limit was 11. According to the Unified Soil Classification System the road surface is a fine grained, clayey silt material of low plasticity (CL-ML).

A summary of the laboratory-determined moisture contents and dimension measurements for the four chip samples is shown in Table 1.

Through both periods of observation a total of 57 loaded coal trucks, 53 empty coal trucks, and 33 passenger vehicles and service trucks traversed the experimental road segment. Average speeds of the trucks were 22 miles per hour (35 km/h), loaded and 27 miles per hour (43.5 km/h) empty.

Photographs of dust plumes stirred by passing coal trucks are shown chronologically in Figures 6 through 14 through the two observation periods. In each figure, photo A shows dust conditions on the road segment treated with wood chips and photo B depicts dust stirred up on the untreated segment. During this experiment it took 5 hours (Fig. 14, A) of traffic use and 21 hours elapsed time for dust plume density on the treated road segment to approach that which existed (Fig. 6, B) on the untreated segments after only ½ hour. When the photos in figure 14 were taken, the moisture content of the road surface on the treated segment was 6.2 percent, a level reached on untreated segments after less than half an hour.

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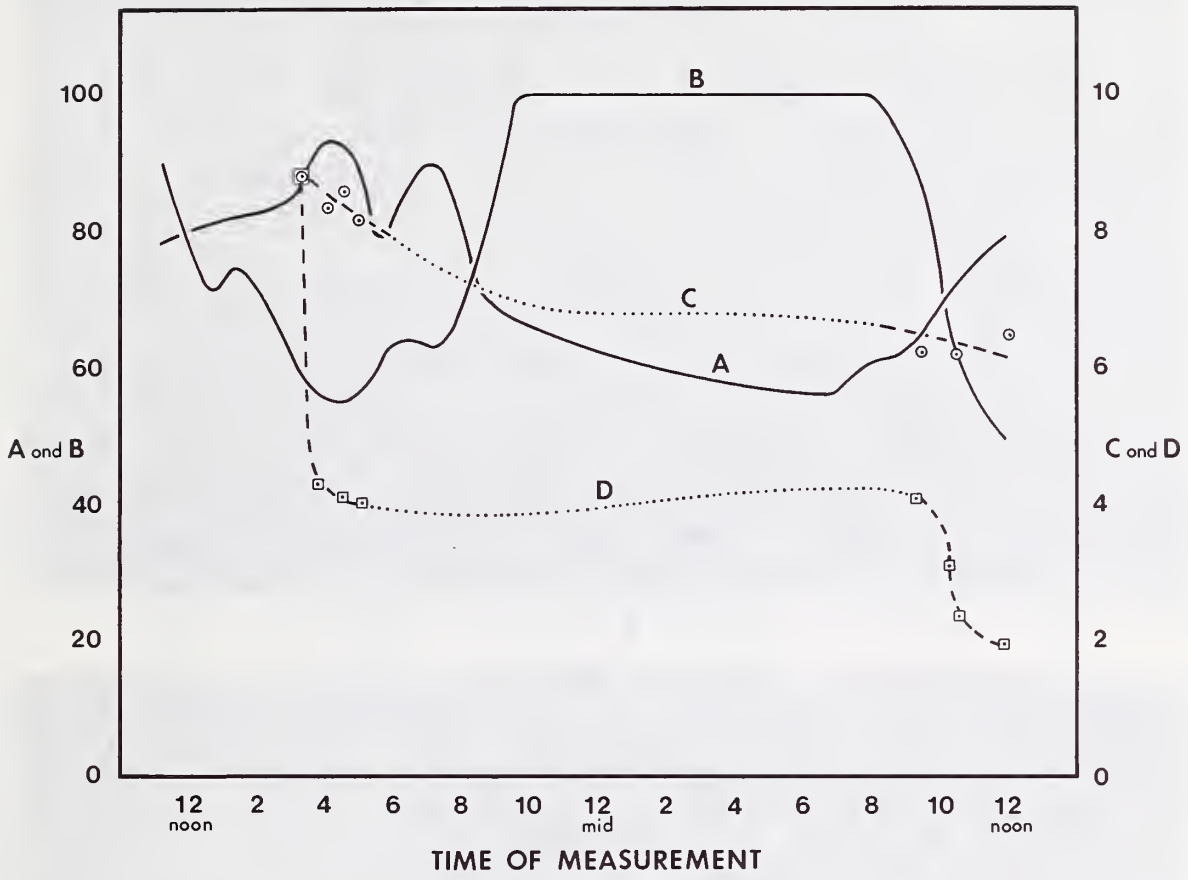
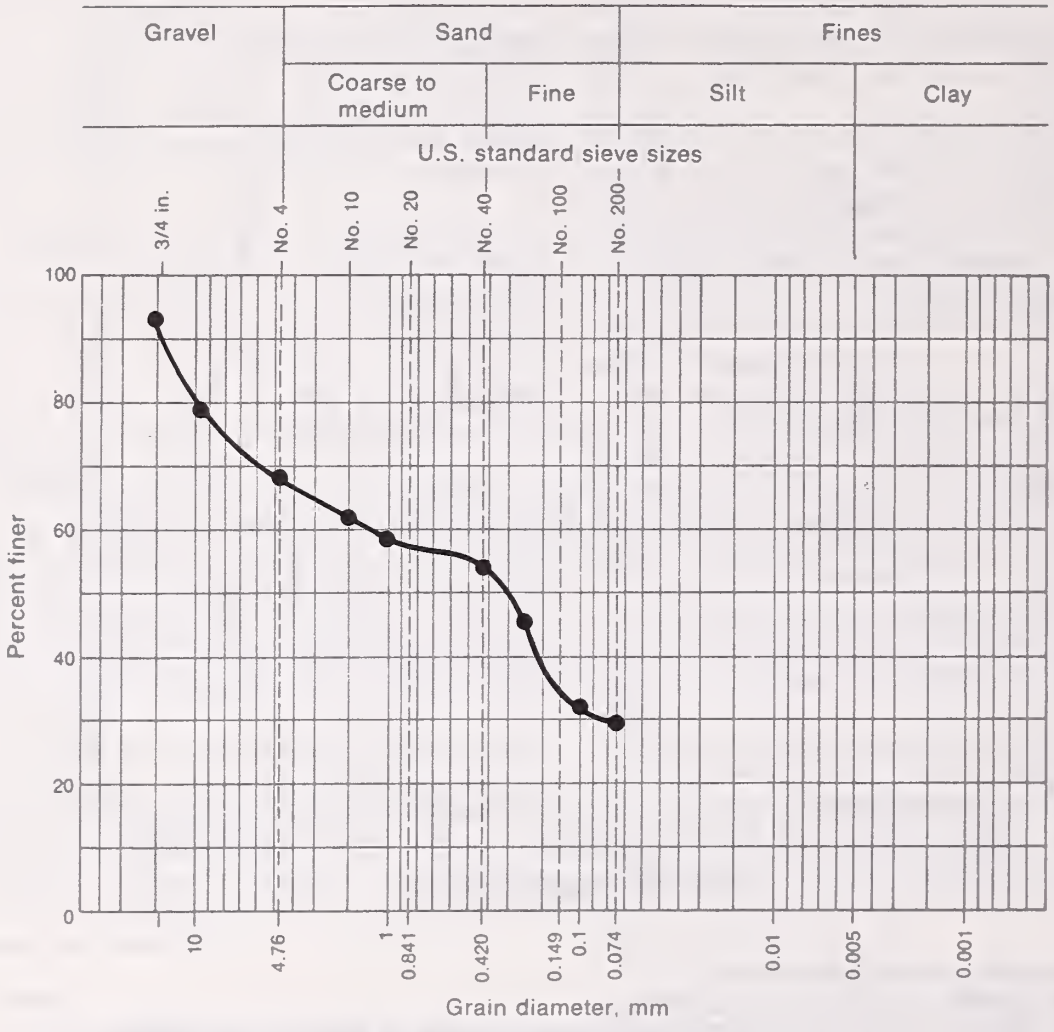
Figure 4.—Ambient temperature and humidity and moisture content of road surface materials throughout experiment.



A—Ambient temperature (°F)
B—Ambient humidity (% saturation)
C—Moisture content of road surface beneath chips, as percent of dry weight
D—Moisture content of road surface not covered by chips, as percent of dry weight

Figure 5.—Particle size distribution of materials in the top 40 mm of road surface.



Liquid limit, 17; Plastic limit, 11; Plasticity index, 6.

Table 1. Mean (and standard deviation) of size and moisture content of wood chips

Sample taken	Length	Width	Thickness	Moisture content
	cm			%
1st day				
3:00 p.m.	2.48 (.358)	1.95 (.627)	1.01 (.136)	65.3
5:00 p.m.	2.77 (.864)	2.08 (.778)	1.02 (.212)	40.6
2nd day				
8:30 a.m.	2.60 (.864)	1.55 (.308)	0.99 (.113)	57.0
12:00 noon	2.40 (.405)	1.46 (.233)	0.97 (.105)	41.7

Figure 6.—Dust plumes at 3:30 p.m. on first day.

Figure 7.—Dust plumes at 4:00 p.m. on first day.

Figure 8.—Dust plumes at 4:30 p.m. on first day.

Figure 9.—Dust plumes at 9:00 a.m. on second day.

Figure 10.—Dust plumes at 9:30 a.m. on second day.

Figure 11.—Dust plumes at 10:00 a.m. on second day.

Figure 12.—Dust plumes at 10:30 a.m. on second day.

Figure 13.—Dust plumes at 11:00 a.m. on second day.

Figure 14.—Dust plumes at 11:30 a.m. on second day.

DISCUSSION

If working hours or hours of traffic use are taken as basis, it may be inferred that under traffic and weather stresses similar to those experienced here, the need to sprinkle for dust control is reduced tenfold by the use of wood chips. But this may not hold true over a medium or long range.

Even in the short time frame of this experiment there was noticeable deterioration in the chips themselves and in the continuity of the chip blanket. Table 1 shows that under 6 hours of traffic-imposed stress, the mean chip width decreased by 25 percent. Also, a slight tendency was noted for traffic to windrow the chips in berms paralleling the road alignment. Should this continue, portions of the treated segment would eventually be swept bare of chips.

Of course a motor grader could rework and respread the chip blanket to eliminate the berms and bare areas. But chip deterioration is permanent and further breakdown under traffic stress is to be expected. Moreover, each time the blanket is reworked and respread the chips will be adulterated with more dust and fine particles from the road surface. Therefore, over an extended period the day-to-day advantage of using wood chips is unlikely to be as great as the tenfold advantage noted during the limited period of this experiment.

But chip deterioration under traffic and contamination of the chip blanket with dust and road surface materials may well be blessings in disguise on the more temporary spur routes. Dudech, Swanson, Mielke, and Dedrick (1970) and Meyer, Johnson, and Foster (1972) found that wood chip mulches reduce erosion and can enhance the survival and growth of vegetative cover on construction slopes. Experience with wood chip mulches on surface mine spoils has indicated their chief potential drawback to be a tendency to deplete the already low nitrogen content of the spoil materials. But this is easily overcome by adequate application of fertilizers. When time comes to abandon, plow under, and revegetate a temporary haul road where wood chips were used to control dust, those same chips will provide a pulverized organic mass ready for use as mulch.

SUMMARY

The results of this preliminary experiment strongly suggest that use of wood chips will allow significant reductions in the day-to-day use of sprinkler trucks to control dust on surface-mine haul roads and that using chips will allow greater flexibility in the scheduling and use of available sprinkler trucks. Too, the protection of the road surface from direct encounter with the forces—draft, pounding, and abrasion—of moving vehicles tends both to forestall the creation of dust-size particles and to prevent those that are present from becoming airborne.

Thus, if converted to chips, the trees that currently are waste materials on a coal surface mine might find valuable use both during the mine operations and afterward when reclamation work is being done.

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